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CONFERENCE OF EMPIRE METEOROLOGISTS, 1929.

AGRICULTURAL SECTION.

IMPERIAL BUREAU OF MYCOLOGY
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Agricultural Meteorology: A Brief Historical Review.

LONDON:
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AGRICULTURAL METEOROLOGY: A BRIEF HISTORICAL REVIEW.

OPENING ADDRESS BY SIR NAPIER SHAW, F.R.S., *Chairman.*

It is with great pleasure and no less surprise that I find myself responsible for inviting an assembly of representatives from many parts of the Empire to consider ways and means of bringing our knowledge of weather to bear upon agricultural practice.

Weather has, of course, been a subject of fundamental importance for agriculturists from the beginning of time. It is, I suppose, of equal importance for all the beasts of the field, for the fowls of the air, the insects that infest it, the fish of the river, the lake and the shallow sea. The lower animals must have shared man's interest in the weather and in fact, if we are to believe famous Greek and Roman authors who wrote about the weather, lower animals are so skilled in knowledge of the subject that they notify coming changes which the lords of creation themselves are too slow-witted to divine; and many people are still of opinion that the very hips-and-haws can foretell seasons. But it is undeniable that the first knowledgeable application of meteorology was the planting of grain in a suitable place at a suitable time of year. That was the basis of the first co-operative movement, the dawn of our civilisation. So interwoven is the farmer's life with the knowledge of weather that one of the great difficulties in developing the application of meteorology to agriculture has been that, knowing as everyone does that the growth of plants and animals depends on sun and warmth and rain, we could not persuade the farmers to tell us how much sun, how much warmth, how much rain was necessary for a bumper crop. I have said it before, and will say it again, that agricultural meteorology is what the farmer knows and won't say.

But the farmer must have lived there for some time, and his father before him, before he finds a working knowledge of weather bred in his bones. At Washington once, on a visit to the Secretary for Agriculture of the United States (who was in fact a Scotchman, which means a good deal in agriculture), I was much impressed by his telling me why it was necessary for the Ministry of Agriculture to have its Weather Bureau. At that time a great deal of the United

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States was virgin soil and the people who were to till it came from all parts of Europe and had not even that rudimentary knowledge of the relation of crops to sites and seasons that I have called the dawn of civilisation. The lesson that James Wilson gave me in Washington comes back to me with more than its original force as I stand in front of an assembly that has to think about the cultivation of crops in the British Empire. If the range of climate and weather in the United States of America requires a Weather Bureau to prevent its citizens' efforts from being wasted, for want of knowledge of the weather and its meaning in beneficence and maleficence, what sort of Weather Bureau does the British Empire require in order to make the most of the soil that it possesses ?

Our own Meteorological Office was started in 1854 for the sea and navigation, not for the land and agriculture. I should not be a bit surprised if the Government of 1854 were of opinion that if anybody wanted to know anything about the weather and climate of the United Kingdom it would be better to ask a farmer than a Fellow of the Royal Society. We are now, of course, in a new world ; but probably there have been Ministers since 1854 who have had the same opinion.

Anyway, in 1877, after ten years of inquiry by a committee of the Royal Society into the relation between meteorological records and weather, a new Council entrusted by the Royal Society with the control of the Weather Office began at once to take up the question of the application of meteorology to agriculture and public health. It was a very strong body of scientific men to whom the control of meteorological work was entrusted. The people who were then thinking about the relation of weather and crops were : Henry Smith, a versatile professor of mathematics at Oxford, who died too soon ; Warren De la Rue, a pioneer in the study of the sun ; Francis Galton, George Gabriel Stokes and Richard Strachey, with Captain Evans, *ex officio*, as hydrographer of the Navy, all famous men. For help with their agricultural scheme they consulted two other persons, whose names will be well known in this assembly, J. B. Lawes and J. H. Gilbert, of Rothamsted. We look to the same quarter for advice to-day. In order best to serve their common purpose the council arranged to collect information about warmth and rain and sunshine from representative stations in twelve districts of the British Isles and to publish it weekly every Wednesday, so that the public authorities might have their information about climate and weather almost as hot as their morning bacon. The first number was issued at the beginning of February, 1878—and the last at the end of January, 1928.

That was the expression of their ideas about practical climatology. Their effort in synoptic meteorology was to issue special forecasts of weather in the harvest season. The publication of forecasts, after some years of intermission for the purpose of study, had been resumed

on 1 April, 1879. The following paragraph appears in their Report for the year ended 31 March, 1880 :—

> " *Hay Harvest Forecasts.*—In order to put the forecasting system to a practical test, the Council, in the month of June, 1879, made proposals to the Royal Agricultural Society, the Royal Dublin Society, and the Highland Society, to send daily forecasts *gratis* during the hay season to a number of observers selected by the Councils of those Societies, on the two conditions, that the information should be made as widely known as possible, and that a record should be kept of the value of each prediction."

Then follows a list of the recipients of the forecasts to the number of 32.

The same paragraph is repeated in practically the same words in the Report of each year until 1899. In 1900 the following paragraphs appeared :—

> " *Harvest Forecasts.*—The practice of distributing, by telegraph, special Forecasts to a selected number of prominent Agriculturists in the several districts of England, Scotland, and Ireland during the period of harvest, had been continued for a long period, in order to give the Council an opportunity of putting the Forecasts to a practical test. The returns of success and failure were made up from the observations of the recipients themselves, and for many years past the totals of partial and complete success had reached an average of about 90 per cent. for all districts, varying from 76 per cent. for Ireland, N., to 96 per cent. for England, S."
>
> " In May, 1899, the Council decided that the free distribution of the Forecasts should be discontinued, and a circular was issued announcing this decision, and stating that the Forecasts would be sent to applicants who were willing to pay the cost of the daily telegram, without any additional charge. Twenty applications for the Forecasts were received, one from Scotland, W., and the remainder from the various districts of England, and Forecasts were sent daily at 3.30 p.m. for varying periods extending in the whole over eight weeks."

In 1901 the number of subscribers increased to 129.

In these days when the conclusions drawn from a map prepared from observations made in almost any part of the northern hemisphere at 6 o'clock can be issued by " wireless " at 9 o'clock to a million listeners, we ought to recall the difficulties of distribution with which the meteorologists of the past century had to contend. The main map of the day was based on observations at 8 a.m., a more restricted service of telegrams reported observations at 1 p.m. and 6 p.m. Forecasts were prepared for issue at 11 a.m., 4 p.m. and 8 p.m : the first for exhibition on the office door at 63, Victoria Street, at three places in the City, six places in the West End, and for the London evening papers ; the second for exhibition as before and for London and Provincial papers and 125 other subscribers. The 8 p.m. forecasts were originally prepared for *The Times* and then for other subscribing newspapers until it was arranged with Government that they should be supplied at the public expense for the papers of the following morning.

Looking back I think we may say that really an antecedent condition for a successful system of forecasting for agricultural purposes is an effective scheme of distribution by wire or wireless. For farmers, reports by post or newspaper can only be reminiscent. The Council were as fully aware of this as you or I ; but the Post Office of those days was a Government Office and the Council's office was not. For the Postmaster General it was merely a regular customer. Its telegraphic information had to be paid for in full and had to take its turn with the messages of the general public. An official of the Post Office once informed me, with all the appearance of pride, that the priority in the Post Office was by turn and nothing else. He explained that a telegram from the Police to arrest a murderer would have to wait its turn while a telegram to put half-a-crown on a horse race was being sent. It required the Great War to secure priority for weather telegrams, and then it was indeed such priority as we had never dreamed of.

When a committee of the Privy Council on Agriculture was appointed the Office appealed for a better trial of the forecasts than it was able to afford itself and in 1893 and again in 1894 trials for selected districts were made. The recipients kept notes of the weather. The harvest forecasts and the weather notes were treated as the material on which to form a judgment about the utility of forecasts and submitted for examination—to a farmer? No! to a local resident squire or parson who knew something about crops and the difficulty of getting them? No!—to a lecturer on Geography in one of the University Colleges. What could anyone in that position say except that no forecast is likely to fit in with the geography of a whole district in England, Scotland or Ireland? It was a foregone conclusion. The report explained what every forecaster knew better than anyone else, and so the experiment was judged to have failed. May I draw this lesson—that if any of you gentlemen are arranging to issue forecasts for the use of agriculturists in your country and you want to know whether they are useful, don't ask an independent meteorologist to report on your scheme, ask your farmers about their crops and how they got them. Keep your difficulties to yourselves and get over them as quickly as you can : judge your service by its usefulness to those whose work is with crops.

Such is in brief the history of our efforts in the direction of Agricultural Meteorology from 1879 to 1899. During the next twenty years I had some personal share in the responsibility for its development.

As official documents passed through my hands I was impressed with the advantages of the Weekly Weather Report for the purpose for which it was planned and the care that was taken to provide appendices that might stimulate research into the agricultural influence of weekly weather. But in this country, where the study of weather is hardly recognised in higher education, the stimulus

has met with little response. One of the novelties of the report was that at Gilbert's request it estimated warmth as accumulated temperature above or below 42° F., and I was curious to know how that scheme worked ; so I put together the results for the twenty years and, knowing hardly anything of crops myself, I was astonished to find that productive barley years were the colder years, not the warmer ones, and that the climate of Eastern England was, in fact, too warm for barley.

Here let me interpolate a story. An ingenious member of my staff demurred to the conclusion. He thought that the method of dealing with such questions by averages of warmth and crops for districts was inadequate. For him the only safe way of arriving at a conclusion was the experimental way—watch your plant all the time and measure the warmth which it received. So he sowed some barley in a pot in his own greenhouse where the conditions of temperature and water supply were under his own observation. When I inquired later how the experimental plan was getting on it turned out that most unfortunately and quite unaccountably the plants had died. But after all it was a very illuminating experiment. I remain still unconvinced that the method of districts and crop returns is not the best way of dealing with mortal things like plants.

Pursuing the matter further I found that the wheat yields for the whole of England, in the years for which the Board of Agriculture provided data, displayed a curious inverse relationship with the rainfall of the previous autumn. You may hear something about it later on. I remember showing the figures to Sir Francis Galton, who had by that time retired from the Council. The gratification that he expressed at something of practical interest having come out of the work in which he had taken a leading part is one of the most pleasurable reminiscences of my life.

By that time a good friend who was a member of the Council of the Statistical Society insisted upon my joining that body, and then, on writing a paper, and as I had satisfied myself that the Weekly Weather Report presented the best thought-out body of meteorological statistics in the world, I naturally used the opportunity to expound its advantages and worked out the relation of wheat crop to autumn rainfall for the Eastern district of England. That still remains for me a subject of natural curiosity and two years ago I was astonished to find a reproduction of the diagram which I had drawn used in a German school of geophysics as the introductory illustration of a general principle.

Thereafter Mr. R. H. Hooker took up the question of the relation of weather and crops on proper statistical methods and with Mr. Yule's assistance developed the method of partial correlation coefficients. The method has spread all over a large part of the world, particularly in India, Sweden and the United States. In the meantime a good deal of useful work on experimental lines was done in Russia, so that before the War the International Meteoro-

logical Committee appointed a committee to study meteorology in relation to agriculture. It is now under the able chairmanship of Dr. Wallén, of the Swedish Meteorological and Hydrographical Service.

The next stage, so far as I am concerned, was in July, 1912, when I was bidden to give a lecture before a Conference of Agricultural Teachers at Cambridge on Meteorology and Agriculture. I doubt if at that time one could have found a more difficult subject for a lecture. It opened with the remark :—

> " There is a wide-spread opinion, more often hinted at than expressed, that meteorology is of great importance in agriculture ; yet when one looks around for monumental evidence of its achievement in this country, except for some successes in forecasting, there is little to be seen."

No one doubts that weather is still of the utmost importance in agriculture, as it was in the beginning ; but meteorology is not weather, it is the study of weather—a different thing.

Since that time the position has been changed. So far as I knew, any good seed that I tried to scatter on that occasion had fallen by the wayside. Shortly after, the War intervened ; yet when the War was over the same desire for co-ordinating the knowledge of meteorology with that of agriculture found expression in the establishment of the Crop Weather Scheme by the co-operation of the Air Ministry with the Ministry of Agriculture. You will hear what has been done and is being done in that way in this and in other countries. Month by month we can see the subject expanding and our purpose to-day is to exchange the experience of methods and results obtained in this country with those of other parts of the Empire.

It has developed far beyond the powers of an ordinary mortal like myself to follow its details.

I am still impressed with the flexibility and power of a weekly report. But in that matter the rationalization of our industry is hampered by the irrationality of what I will call the monthly habit of meteorologists. In this connexion I think we ought all to bear in mind the proposals for the reform of the Calendar which are designed to rationalise the measurement of time, not so much for scientific as for commercial purposes. They have been put forward by the U.S.A. and have been taken up by the League of Nations with the suggestion of an " International Conference to decide Calendar Reform."

The following notification comes to me with a post mark S.W.1 :

> " International Chamber of Commerce, Amsterdam Congress.
>
> " The International Chamber of Commerce, earnestly desiring that the date of Easter should be fixed without delay, and that the calendar should be reformed, reaffirms at its 5th Congress in Amsterdam its previous resolutions of the 1st Congress at London, 1921, the 2nd Congress at Rome, 1923, and the 3rd Congress at Brussels, 1925.

"The Chamber notes with satisfaction that several nations at the instance of the League of Nations have organized special committees to study calendar improvement and the fixing of Easter.

"The Chamber urges that other nations should follow that same practical course, and that the League should convene an international conference to secure without further delay the improvement for which the world's commerce has so often asked."

I do not gather that the reform of the calendar excites much interest in this country. Indeed, when I broached the question in a paper before the Royal Statistical Society in 1925, "On the week or month as an intermediate time-unit for statistical purposes," the Government officials who took part in the discussion seemed to think that the present lack of system, in spite of all its imperfections, was better than anything else. Still the International Chamber of Commerce may have an influence with Boards of Trade and Ministries of Air and Health that simple reasoning does not command. All I would say now is that we are not much concerned about a fixed or movable Easter, that for meteorology or agriculture there is no such thing as a *dies non*, and I doubt very much if there can be one for commerce—certainly a Bank Holiday is not one. If there is a day to spare from the calendar it might be spent in universal work for some laudable object of universal interest, say the League of Nations or, better, the organisation of a universal campaign against the minor enemies of mankind.

But the choice of a time-unit is really a subject of vital importance for the proper organisation of the endeavour to co-ordinate agricultural progress with the study of weather. In my capacity as President of the Meteorological Section of the International Union for Geodesy and Geophysics, in accordance with a resolution passed at Prague in 1927 I have to organise a deputation to the International Meteorological Committee this year. I am afraid that illness has stunted my personal activity, but if you agree with me that choice of a time-unit is a really important matter, you may make some amends for my enforced inactivity.

Let me, in conclusion, say a word or two that I hope may be regarded as in season in opening a conference upon what is practically a new science, and that is the urgent necessity in all sciences for scrupulous care in the choice of words to express new ideas. It is so easy when one is thinking out a subject to borrow for a new idea a word that is already in common use and give it another meaning; if a distinction is to be drawn we are apt to accomplish our desire by adding an adjective.

I wonder how much lead meteorology has lost by using the name absolute temperature for something which for the man-in-the-street is not temperature at all. Our friend in the street is entitled to say to the man of science: "You have encouraged me to buy an instrument to measure temperature; and for me temperature means what I read on that instrument and can mean nothing else." It is not only the man-in-the-street who is misled. Some years ago

two Oxford physicists, Lindemann and Dobson, described some observations from which they concluded that the " temperature " of the air at a height of 100 km. is about 300, and only a few days ago in a paper from Copenhagen I find a discussion based upon the figure 300° C. as the temperature referred to : but 300° C. is 273° C. wrong.

I quote the incident to suggest that as the scientific world has invited the man-in-the-street to read temperatures on a thermometer, it should leave him in possession of the name and find another name for what we scientific folk call absolute temperature. We might have made some progress if we had used a new word, " thermancy " for example and if Lindemann and Dobson had said that the thermancy of the air at 100 km. was 300 the Copenhagen printer would have done no harm.

You may think this is very remote from agriculture, but radiation, the foundation of all agriculture, is reckoned in absolute temperature, not in temperature. When you lose a potato-crop in a night-frost in May, if you are a meteorologist you may perhaps find a grain of scientific consolation in reflecting that it is thermancy that counts, not temperature.

Really one ought not to alter the essential nature of an entity by qualifying it with an adjective, though the attempt is often made. A year or two ago, in a review of a work on the glacial anticyclone, I had occasion to contrast some of its properties with the recognised properties of an anticyclone. The author demurred and explained that anticyclone was not in his book nor in his index ; it was a " glacial anticyclone " not an " anticyclone " that he was talking about.

Such things happen often. When I was at the Meteorological Office we used to keep a catalogue of all gales on the British coasts. The gales we catalogued were defined as winds of force 8 on the Beaufort scale. The meaning of our catalogue was obscured by the fact that force 7 on the Beaufort scale was called a moderate gale, so we altered moderate gale to high wind ; but I see the old notation has become re-established, and if you want an answer to the conundrum : " When is a gale not a gale ? " you must ask a seaman, and he will explain : " When it's a moderate gale."

Let me give one other example of the need for care in the choice of words. Things happen sometimes in nature that are outside the pale of properly organised statistics. You may get a succession of events which to the unsophisticated person looks periodic : you may even guess the period. But the statistician has his own canons of behaviour for periodic things, and when things look periodic and do not satisfy his canon he is apt to say they are " accidental." But for the observant meteorologist, as I suppose for the observant agriculturist, there are problems in nature but certainly no accidents. Accident is, I am sure, quite the wrong word to use. I should understand at once if he called the sequence " ultrastatistical," meaning

that a statistician would not think about it. I should forgive his calling it " infrastatistical " as being beneath the notice of a person who dealt with ordered arrangements of events. But if he calls it accidental I spend all my little leisure for his subject in wondering why he uses such an inappropriate word.

Pray excuse my calling your attention to these small matters. You have a very extensive bill of fare before you, and compared with the subjects in the programme what I have mentioned may be what the French would call " *hors d'œuvre.*" Yet perhaps I may be forgiven if I use another analogy. In science as in transport, switch points have no prominence and yet they have quite considerable importance.

Returning from the minor to the major key—what after all is this Agricultural Meteorology that we are asked to discuss ? Is it meteorology at all ? or is it one of the things that I have referred to, the very nature of which is changed by its epithet ?

We are, of course, agreed that the human race depends upon its agriculture for its food and clothing ; the science of agriculture may fairly be described as the study of the organised reaction between soil and weather, and meteorology is the study of weather. The most obvious feature of this everlasting reaction is that changes in the soil are interminably slow compared with the changes in the weather and the two require different arrangements for their study.

One aspect of Agricultural Meteorology is the presentation of one side of the reaction between soil and weather in any particular agricultural problem ; but that is only one aspect. Another is the presentation of our knowledge of weather in such a form that we can follow in outline, if not in detail, the progress of the reaction in any selected locality. It is this second aspect which makes a special appeal to us to-day. If we organise to the best advantage our knowledge of weather—that knowledge which in the past has merely gone to increase what a distinguished American meteorologist has called the " frozen assets " of the science—we shall obtain a general view of the progress and prospects of agriculture in every part of the Empire.

To devise and organise an arrangement which is equally suitable for all and each of His Majesty's Dominions will require courage as well as ingenuity—courage of a peculiar order if the best arrangement is one which has to override the awkwardness of the Gregorian calendar. But the object of our work, the understanding of the conditions under which the different parts of our wide-flung Empire contribute to the world-supply of food and clothing, is no mean ambition.

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